Addendum to:

Resource Replacement Alternatives Involving Constructed Reefs in Southern California

Evaluation of Artificial Reefs as Restoration Options for Injuries Resulting from DDT in Fish Tissue that Exceeds FDA Action Levels and California State Trigger Levels

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Introduction

This report evaluates the use of artificial reefs as restoration options for injuries due to DDT contamination on the Palos Verdes Shelf. The specific focus is on injuries resulting from DDT in fish tissue that exceeds Food and Drug Administration (FDA) action levels and California State trigger levels. This report is an addendum to my previous report, "Resource Replacement Alternatives Involving Constructed Reefs in Southern California" (Ambrose 1994). Like that report, it is intended for use in the legal action of U.S. vs. Montrose et al. concerning the injuries caused by the release of DDT onto the Palos Verdes Shelf.

Ambrose (1994) focused on reef design and benefit/cost issues without reference to specific injuries. This report focuses on injuries to fish to which FDA action levels and California State trigger levels apply. One goal of this report is to estimate the size of an artificial reef needed as restoration for injuries to these fish. The report includes the estimation of quantitative values needed for calculations in a Resource Equivalency Analysis (REA, also called Habitat Equivalency Analysis).

The period of interest for the analyses in this report is 1980 to 2000. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) was adopted in 1980, so exceedances based on federal action levels are considered from 1981, the first full year after CERCLA adoption. The California State fish advisories were established in 1985 but the trigger level was not set until 1991 (see Appendix 2), so exceedances based on California trigger levels are considered from 1992, the first full year after the trigger level was established. The last year of data included in the analyses in this report is 1999.

Overview of Approach

To determine the size of artificial reef needed to restore injuries to fish to which the FDA action levels and California State trigger levels apply, the size of the injury and the benefits of the artificial reef must be quantified. The injuries and benefits are based on the standing stock of fish in an area, because the standing stock is the amount of fish available to fishermen. In this report, injuries are measured as "exceedances," the proportion of fish in the population that exceed different thresholds of DDT concentrations in edible tissue (muscle), either 5 ppm DDT for FDA action level or 0.1 ppm DDT for California State trigger level (see Appendix 2). DDT as used in this report refers to total DDTs (see Appendix 2). Because standing stocks and exceedances vary over space and time, the analysis takes this variation into account.

The following summarizes the steps taken to determine the size of artificial reef needed to restore injuries due to DDT contamination of fish used by anglers:

1 Estimate injuries due to DDT contamination.

   a) Estimate standing stock of fish.

      i. Estimate biomass density (kg/ha) from trawl or diver surveys. Estimate biomass density for different sections of coast along Palos Verdes Peninsula. For trawl data, use three depth strata: <30 m, 30-100 m, and 100-200 m. For diver estimates, use a single depth stratum: <30 m.

      ii. Estimate habitat area in each section (and each depth for soft-bottom fish).

      iii. Multiply biomass density by area to estimate standing stock in section, sum to get overall standing stock.

      iv. Calculate standing stocks for three periods (1981-86, 1987-91 and 1992-99)

   b) Estimate biomass injured based on exceedances of federal or California standards.

      i. Acquire exceedance estimates for the different coastal sections and time periods.

      ii. Multiply standing stock for each species by exceedances (as proportion of population) to estimate standing stock injured by DDT contamination of fish tissue.

      iii. Sum the standing stock injuries for individual species to get an overall estimate of injuries for each time period. This estimate represents the average standing stock injured each year during the time period.

2. Estimate gains from construction of artificial reefs.

   a) Estimate standing stock of fish on artificial reefs. For comparison, estimate standing stock of fish on natural reefs. Because estimate of injuries is restricted to fish to which FDA action levels and California State trigger levels apply, estimate standing stocks only for fish to which these levels would apply.

3. Calculate size of artificial reef needed for restoration

   a) Calculate size of artificial reef needed for primary restoration as biomass lost (kg) divided by biomass density (kg/ha). Consider two scenarios:

      i. a sediment cap is placed over contaminated sediments and is effective, and

      ii. no sediment cap is placed over contaminated sediments or it is not effective.

b) Calculate size of artificial reef needed for compensatory restoration

   i. Use Resource Equivalency Analysis to determine size of damages (kg-yr) caused by the fish injuries that have occurred since 1981.

      Use Resource Equivalency Analysis to determine size of benefits (standing stock) needed to be produced by artificial reef in order to compensate for damages.

4. Estimate cost of restoration (primary and compensatory) based on size of artificial reef. Possible locations and designs for the artificial reef(s) are also discussed.

3.0 Injuries due to DDT contamination

Four species are considered in this report: white croaker (*Genyonemus lineatus*), Dover sole (*Microstomus pacificus*), kelp bass (*Paralabrax clathratus*), and black surfperch (*Embiotoca jacksoni*). All of these species occur in the Palos Verdes region, are species to which FDA action levels and California State trigger levels apply, and have accumulated DDT in their tissues.

Other species found in the Palos Verdes region and caught by anglers could have been considered, but there was not enough information available for these species to support an analysis. For example, there was insufficient contaminant information for sculpin, rock crabs and yellow crabs. In addition, possible injuries extending beyond the Palos Verdes region or deeper than 200 m off of the Palos Verdes Peninsula were not considered.

For the four target species, injuries were determined by calculating the standing stock (kg) of fish that exceed federal and state health thresholds. In Section 3.1, information on the proportion of the four target fish exceeding the federal and state levels is presented. In Section 0, standing stocks of the four target fish are estimated for the Palos Verdes region. In Section 3.3, information on the standing stocks is combined with exceedances to estimate the biomass injured due to DDT contamination.

In the sections that follow, much of the information is presented in one large table for each of the four target species. Each table contains the information needed to calculate total biomasses exceeding the thresholds, including exceedances, biomass densities, areas per segment, and standing stock per segment. The tables are presented in Section 3.1, but are referred to in later sections as well.

3.1. Exceedances as proportion of standing stock

Exceedance values were provided by QEA in an analysis developed by HydroQual (1997). A description of QEA's analysis is given in Appendix 2. Exceedances are given as proportion of fish exceeding a threshold. Two thresholds were used, 5 ppm corresponding to FDA action levels and 0.1 ppm corresponding to State of California trigger levels.

Exceedances were determined for application to the following time periods, consistent with the time periods determined to be relevant to the specific concentration values:

Dover sole	1981-1986	5.0 ppm
(all depths):	1987-1991	5.0 ppm
	1992-1999	0.1 ppm
Kelp bass, black	1981-1986	5.0 ppm
surfperch:	1987-1991	5.0 ppm
	1992-1996	0.1 ppm
White croaker:	1981-1986	5.0 ppm (deeper than 30 m)
	1987-1991	5.0 ppm (deeper than 30 m)
	1981-1991	5.0 ppm (shallower than 30 m)
	1992-1999	0.1 ppm (all depths)

Exceedances were estimated for different segments of the Palos Verdes Peninsula. HydroQual (1997) previously described the coastal segments I use in this report, with two modifications. HydroQual's originally identified eight segments covering the Palos Verdes Peninsula, numbered 3 through 10. QEA added a new segment, 4.5 (called 4A in QEA's report, Appendix 2), mostly within the original segment 4, and shifted the boundary between 4.5 and 5 slightly eastward. Approximate coordinates for shoreline boundaries and compass headings for the coastal segments are given in Figure 1. Note that HydroQual's segments 3 and 10 are larger than shown in the figure; I truncated them for my analysis because they extend beyond the Palos Verdes Peninsula region. The regions of segments 3 and 10 that are not included in this analysis are sufficiently different from the PV Shelf area that biomass estimates from the LACSD trawls should not be extrapolated to them. No estimates were made for segment 10 because there were no exceedance estimates for the portion of 10 that would be included in my analysis.

The exceedances for white croaker, Dover sole, kelp bass and black surfperch are given in Table 1, Table 2, Table 3, and Table 4. For each table, *italics* font indicates that the value for that cell was estimated. Heavily shaded cells indicate that an estimate could not be made because of a lack of data. The inability to estimate exceedances was especially prevalent for white croaker, particularly for the shallow depth zone, where there were data for only two segments. Lack of an exceedance estimate for segment 8 in 1992-99 had a large effect on the final injury estimate because of the large standing stock of white croaker in that segment. Lack of an exceedance estimate for kelp bass in 1992-96 for segments 8 and 9 may also have had a large effect on the final injury estimate because of the large standing stock in those segments. The lack of exceedance estimates results in an underestimate of the injury.

Figure 1. Shoreline segments used for standing stock and contaminant analyses in the Palos Verdes region. Contour lines going from inshore to offshore represent 30m, 100m and 200m depths.